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| 10/697,393 | 10/30/2003 | Thomas Holtzman Williams | | 7468 |

7590 06/26/2007

THOMAS H. WILLIAMS
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| EXAMINER | |
|---|---|
| CORRIELUS, JEAN B | |
| **ART UNIT** | **PAPER NUMBER** |
| 2611 | |

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|---|---|
| 06/26/2007 | PAPER |

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

| Interview Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 10/697,393 | WILLIAMS, THOMAS HOLTZMAN | |
| | Examiner | Art Unit | |
| | Jean B. Corrielus | 2611 | |

All participants (applicant, applicant's representative, PTO personnel):

(1) Jean B. Corrielus. (3)_____.

(2) Thomas H. Williams. (4)_____.

Date of Interview: 19 June 2007.

Type: a)☒ Telephonic b)☐ Video Conference
c)☐ Personal [copy given to: 1)☐ applicant 2)☐ applicant's representative]

Exhibit shown or demonstration conducted: d)☐ Yes e)☐ No.
If Yes, brief description: _____.

Claim(s) discussed: 1-8.

Identification of prior art discussed: Applicant's admitted prior art and Guchi.

Agreement with respect to the claims f)☐ was reached. g)☒ was not reached. h)☐ N/A.

Substance of Interview including description of the general nature of what was agreed to if an agreement was reached, or any other comments: The attached proposed amendment was discussed. Applicant was advised that the claims as amended would not be sufficient to overcome the outstanding art rejection.

(A fuller description, if necessary, and a copy of the amendments which the examiner agreed would render the claims allowable, if available, must be attached. Also, where no copy of the amendments that would render the claims allowable is available, a summary thereof must be attached.)

THE FORMAL WRITTEN REPLY TO THE LAST OFFICE ACTION MUST INCLUDE THE SUBSTANCE OF THE INTERVIEW. (See MPEP Section 713.04). If a reply to the last Office action has already been filed, APPLICANT IS GIVEN A NON-EXTENDABLE PERIOD OF THE LONGER OF ONE MONTH OR THIRTY DAYS FROM THIS INTERVIEW DATE, OR THE MAILING DATE OF THIS INTERVIEW SUMMARY FORM, WHICHEVER IS LATER, TO FILE A STATEMENT OF THE SUBSTANCE OF THE INTERVIEW. See Summary of Record of Interview requirements on reverse side or on attached sheet.

JEAN B. CORRIELUS
PRIMARY EXAMINER 6-25-07

Examiner Note: You must sign this form unless it is an Attachment to a signed Office action.

Examiner's signature, if required

Thomas H. Williams
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# facsimile transmittal

| | | | |
|---|---|---|---|
| **To:** | USPTO | **Fax:** | 571-273-3020 |
| **From:** | Thomas H. Williams | **Date:** | June 18, 2007 |
| **Re:** | 10/697,393 | **Pages:** | 14 |
| **CC:** | | | |

☑ Urgent ☐ For Review ☐ Please Comment ☐ Please Reply ☐ Please Recycle

Attn: Jean B Corrielus

Attached find a 3rd proposed Draft Response to a First Office Action.

Please call me at the phone number below when after you have had a chance to review this draft. Thanks.

Regards,

Thomas H. Williams

303-449-9070 (PH)

303-444-7698 (FAX)

303-817-1895 (CELL)

# DRAFT – FOR EXAMINER REVIEW ONLY!

S/N 10/697,393 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Thomas Holtzman Williams | Docket Number:

Serial Number: 10/697,393 | Examiner: Jean B. Corrielus

Filed: Oct. 30, 2003 | Art Unit: 2611

Title: **DIGITAL TRANSMISSION SYSTEM USING NON-ORTHOGONAL MATRICES**

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

**RESPONSE TO OFFICE ACTION**

Dear Sir:

Responsive to the Office action mailed March 15, 2007, applicant respectfully submits this Response to Office Action.

**Amendments to the Abstract** begin on Page 2 of this paper

**Amendments to the Specification** begin on Page 3 of this paper.

**Amendments to the Claims** are reflected in the listing of claims, which begins on page 5 of this paper.

**Remarks/Arguments** begin on page 7 of this paper.

**Amendments** to the Drawings begin on page 9 of this paper

## Changes to the Abstract

A digital modulation technique that utilizes a spreading matrix to linearly transform an input symbol sequence into a transmit symbol sequence using a two-dimensional transmission matrix comprised of non-orthogonal basis functions. The transmit symbol sequence is filtered, modulated, and transmitted over a channel. At the receiver, a received symbol sequence is captured, demodulated, equalized if needed, and again transformed with a recovery matrix that is an inverse of the spreading matrix that was used at the transmitter. ~~By using an inverse matrix instead of a more conventional transposed matrix, it is possible to construct a matrix from non-orthogonal basis functions.~~ The transmission matrix may be over-determined, creating more transmit symbols for increased robustness. Alternately, the transmission may employ transmission matrices that perform both spreading and frequency transforms, thereby creating spread frequency domain symbols. ~~This allows much greater flexibility in determining the properties of a transmitted symbol sequence. If a non-square transmission matrix is used, the number of symbols in the transmit symbol sequence may exceed the number of symbols in the input symbol sequence, creating redundant symbols. The redundant symbols may be used to replace any of the transmit symbols that were damaged by transmission impairments. Alternately, the redundant transmit symbols may be used to reduce the effects of random noise in an output symbol sequence. The transmit symbol sequence may optionally be transformed a second time at the transmitter by an inverse fast Fourier transform (IFTT) prior to transmission, in a technique comparable to OFDM (orthogonal frequency division multiplexing). The second transform process converts time domain symbols into frequency domain symbols. If some of the frequency domain symbols fall into frequency-selective deep channel fades, which are frequently encountered in wireless channels, redundant transmit symbols can be used to insure error free reception.~~

**Changes to the Specification**

Please amend the specification with the following changes:

Page 2, lines 15 -16. A DSSS matrix may be comprised of rows of pseudo-noise (PN) sequences, which are orthogonal to each other.

Page 4, lines 5 -11. Additionally, the present invention may be comprised of a two-dimensional transmission matrix that is over-determined, creating a transmit symbol sequence, which contains more symbols than are in the input symbol sequence. The additional (excess) symbols are redundant symbols. Corrupted symbols in the received symbol sequence may be discarded, and replaced by redundant uncorrupted symbols. A recovery matrix is formed by computing an inverse of a transmission matrix that has been modified by dropping ~~rows~~ columns corresponding to corrupted terms in the received symbol sequence.

Page 9 line 6 to page 10 line 4. Fig 3 is a numeric matrix multiplication example 300 using a non-orthogonal over-determined matrix, which can be referred to as a "mother" matrix. An input symbol sequence 302 with 5 terms has been formed from data. A two dimensional mother transmission matrix 304 is comprised of non-orthogonal rows. Note that the transmission matrix 304 has 6 columns but only 5 rows, so it is an over-determined matrix. A transmit symbol sequence 306 is created by multiplying the input symbol sequence 302 by the transmission matrix 304. The use of an over-determined transmission matrix creates 6 terms in the transmit symbol sequence 306 from only 5 terms in the input symbol sequence 302. This 6-term transmit symbol sequence is sent over a signal path. Assume, for example, that the 5th symbol (the term with a value of –2) has been corrupted in transmission, and has therefore been omitted from a truncated received symbol sequence 308. The original input symbol sequence

may still be recovered by multiplying the truncated received symbol sequence by a daughter inverse recovery matrix. Dropping the ~~row~~ column of the mother transmission matrix 304 that corresponds to the corrupt term in the truncated received symbol sequence creates the daughter matrix. If the 5th ~~row~~ column, corresponding to the 5th corrupt received term, is removed from the transmission matrix 304, a daughter transmission matrix with the corrupt ~~row~~ column removed 310 is created. It has been labeled C5 to designate that the 5th column is removed. If the C5 inverse is computed, a recovery matrix 312 is found. The output symbol sequence 314 is computed without error by multiplying the truncated received symbol sequence 308 by the inverse of the truncated daughter transmission matrix 312.

**Claim Listing**

What I claim is:

1. (amended) A digital transmission system comprising:
   a. a transmitter transmitting a transmit symbol sequence that has been created by multiplying an input symbol sequence by a transmission matrix, said transmission matrix being comprised of non-orthogonal basis functions;
   b. a signal path,
   c. a receiver receiving a received symbol sequence, and
   d. a processing element multiplying the received symbol sequence by a recovery matrix, said recovery matrix is an inverse of the transmission matrix, whereby an output symbol sequence is produced.

2. (amended) A digital transmission system according to claim 1, wherein the transmission matrix is square ~~and the recovery matrix is the inverse of the transmission matrix~~.

3. (amended) A digital transmission system comprising:
   a. a transmitter transmitting a transmit symbol sequence that has been created by multiplying an input symbol sequence by an over-determined transmission matrix, said transmission matrix being comprised of non-orthogonal basis functions;
   b. a signal path,
   c. a receiver receiving a received symbol sequence, and
   d. a processing element multiplying the received symbol sequence by a recovery matrix, said recovery matrix is a pseudo-inverse of the transmission matrix, whereby an output symbol sequence is produced.

4. (canceled) ~~A digital transmission system according to claim 3, wherein the recovery matrix is a pseudo-inverse of the transmission matrix.~~

5. (amended) A digital transmission system according to claim 3, wherein the processing element removes ~~redundant~~ corrupt symbols in the received symbol sequence and ~~a~~ said recovery matrix is created from an inverse of ~~the transmission matrix with the corresponding columns removed~~ a daughter transmission matrix.

6. (amended) A digital transmission system comprising:

a. a transmitter transmitting a transmit symbol sequence that has been created by multiplying an input symbol sequence by a transmission matrix comprised of non-orthogonal basis functions and performing an inverse fast Fourier transform in the result;

b. a signal path,

c. a receiver receiving a received symbol sequence, and

d. a processing element performing a fast Fourier transform and multiplying the received symbol sequence by a recovery matrix, said recovery matrix is an inverse of the transmission matrix, ~~and performing a fast Fourier transform,~~ whereby an output symbol sequence is produced.

7. (original) A digital transmission system according to claim 6, wherein a guard interval is added to the transmit symbol sequence.

8. (amended) A digital transmission system according to claim 6, wherein the processing element removes corrupt symbols and ~~a~~ said recovery matrix is created from an inverse of ~~the transmission matrix with the corresponding columns removed~~ a daughter transmission matrix.~~,~~

## Remarks

Claims 1-8 were originally pending in this application. By this amendment, claims 1 – 3, 5 – 6 , and 8 have been amended. Claim 4 has been canceled. Claim 7 is unchanged.

Claims 5 and 8 were objected to be cause of the following informality: "a recovery" needed to be replaced by "said recovery". This change was made to claims 5 and 8. In addition, the extra period was deleted. Claims 5 and 8 have accordingly been amended and it is believed that these objections are now moot.

Claims 5 and 8 were rejected under 35 U.S.C. 112 because the term "the corresponding column" lacks proper antecedent basis. This term has been replaced with "a daughter matrix" which has antecedent basis. The same comment applies to claim 8. They have accordingly been amended and it is believed that these objections are now moot.

Claims 1-8 were rejected under 35 U.S.C. 103(a) as being unpatentable over applicants admitted prior art fig. 1 in view of Kuchi et al US Patent No. 7,006,579.

Claim 1. The admitted prior art describes signal transmission methods to transmit signals that have been transformed using transmission matrices with orthogonal basis functions, and receive the signals with recovery matrices that are transposes of the transmission matrix. The cited prior-art methods, DSSS (direct sequence spread spectrum), OFDM (orthogonal frequency division multiplexing), and wavelet modulation all use transmission matrices comprised of elements that are fixed numbers, and recovery matrices that are also fixed numbers, as is well-known in the art. The present invention also uses transmission matrices and recovery matrices that are comprised of fixed numbers. For instance, see the numerical example of Fig. 3.

In the Kuchi patent, the elements of the transmission matrix are formed by using the symbols, the complex conjugates of the symbols, and the negative complex conjugates of the symbols. Conjugation is not a fixed number, but a mathematical function, an operation upon a number. Fixed matrix elements are required to compute an inverse matrix. Thus, an inverse matrix cannot be computed from a matrix employing elements that are mathematical functions, as taught in the Kuchi patent, and incorporating the admitted prior art with the Kuchi patent is non-obvious. Furthermore, Kuchi does not teach use of an inverse of the transmission matrix. Claim 1 has been modified with the added term "said recovery matrix is an inverse of the transmission matrix" to clarify the claim.

Claim 2. Claim 2 has been revised to move the "inverse matrix" term into independent claim 1. This claim should be allowable because it is dependent upon an allowable claim 1.

Claim 3. It would not be obvious to create an overdetermined matrix with more rows than columns because an inverse matrix can only be created from a square matrix that is non-singular. The term "said recovery matrix is a pseudo-inverse of the transmission matrix" has been added to claim 3.

Claim 4 has been removed.

Claim 5. This claim should be allowable because it is dependent upon an allowable claim 3.

Claim 6. Cited prior art does not teach transforming a previously transformed signal into frequency domain symbols using a second transform. In claim 6 the order of the transforms performed at the receiver have been reversed to reflect

the order of the steps in Fig. 5. The term "recovery matrix is an inverse of the transmission matrix" has been added to clarify this claim.

Claims 7 and 8. The remaining pending claims are directly or indirectly dependent on an allowable independent claim, and at least for this reason are also allowable. Reconsideration of this application is respectfully requested.

The first correction to the specification is an omission. The second and third corrections correct use of the word "row" when "column" was intended.

**Abstract**
The abstract has been shortened.

**Drawings**
"(PRIOR ART)" is be added underneath "FIG 1" in a replacement sheet FIG 1.

The word "ROW" has been replaced with "COLUMN" in a replacement sheet FIG 3. The error is evident when examining the numerical example of FIG 3.

Applicant believes no new material has been added.

Reconsideration is respectfully requested. The applicant believes the application to be in condition for allowance, and such action is earnestly requested.

Dated this 18TH day of JUNE, 2007.

Respectfully submitted:

Thomas Holtzman Williams

Thomas H Williams

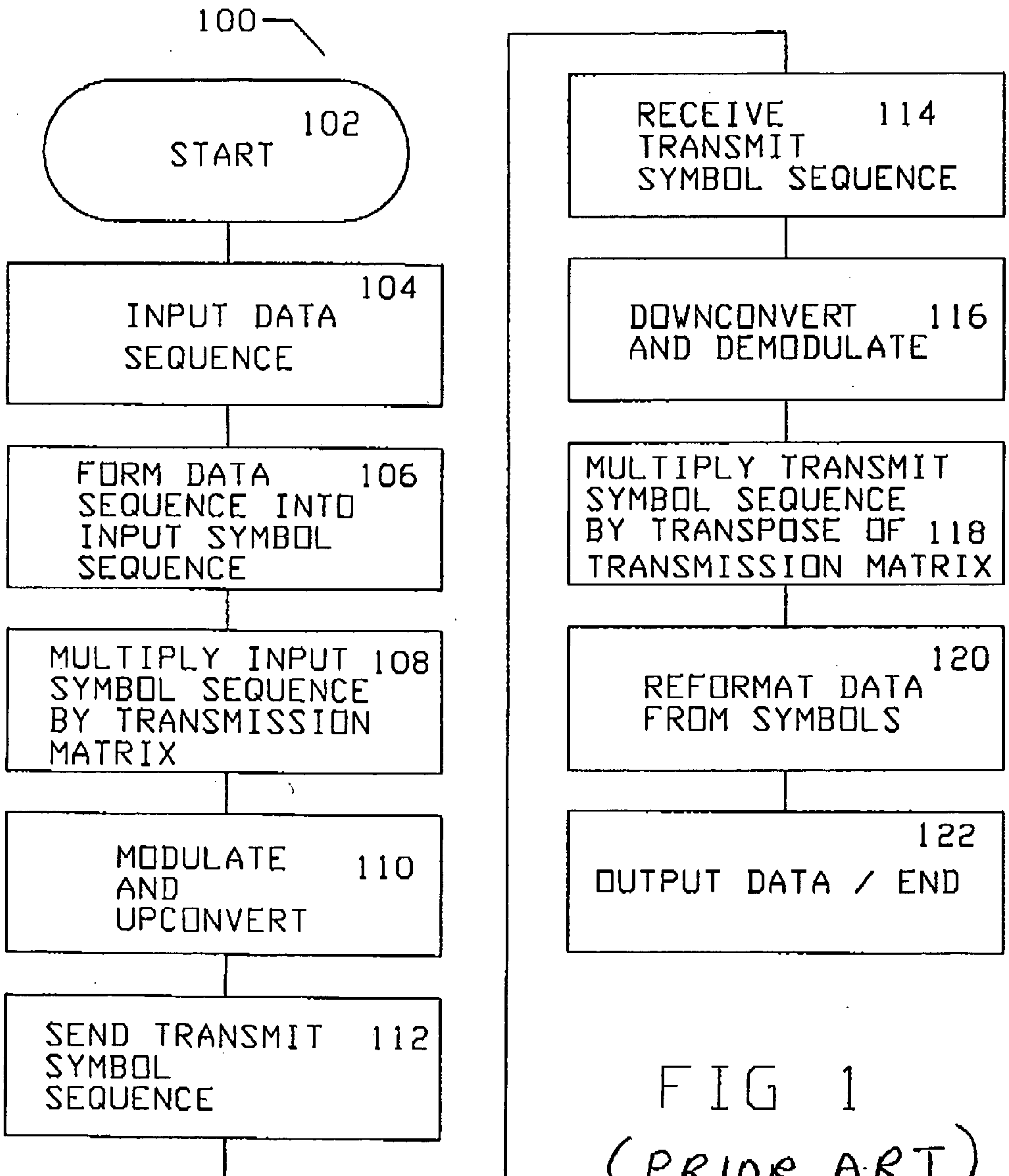


FIG 1
(PRIOR ART)

REPLACEMENT SHEET

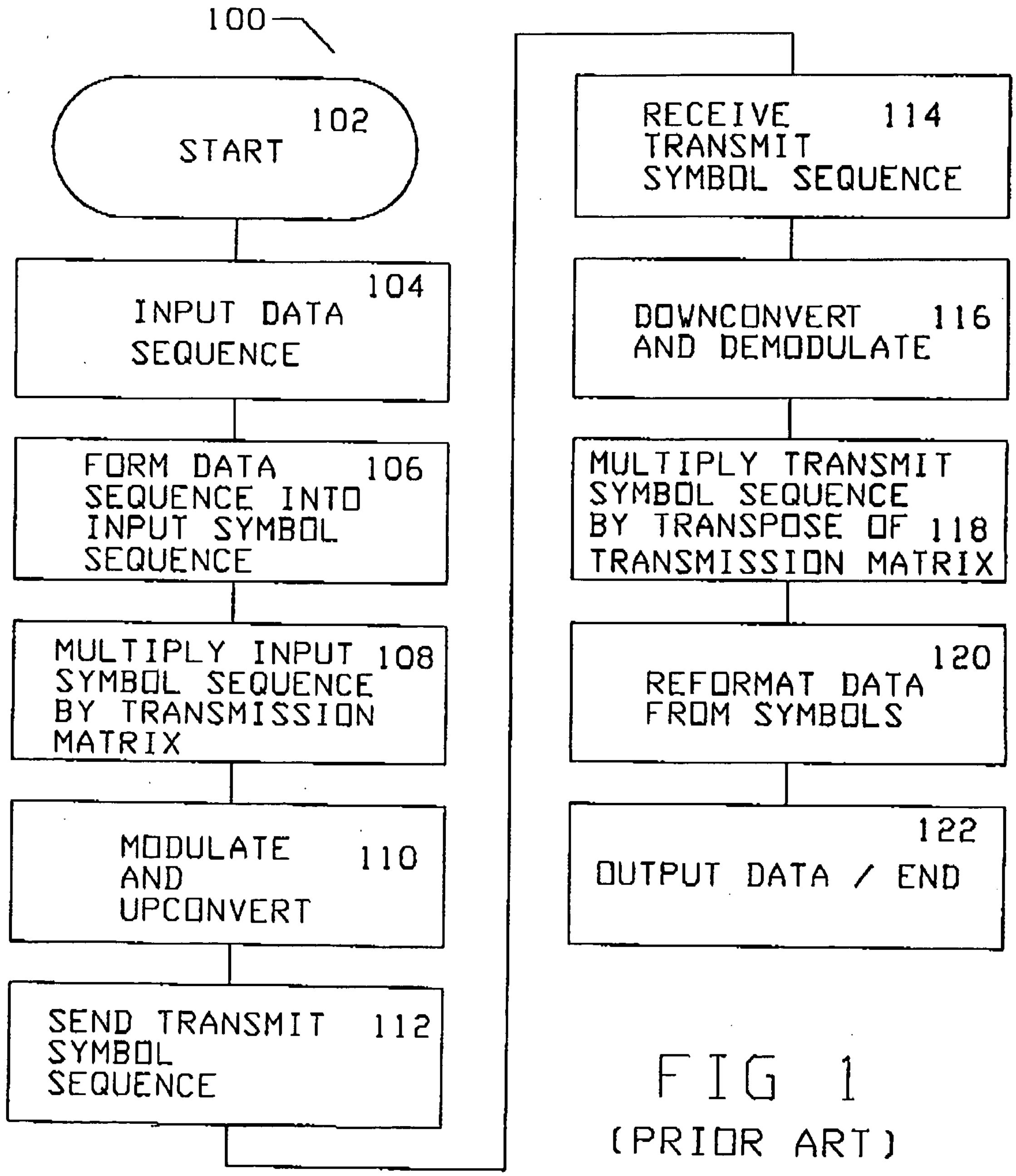


FIG 1
(PRIOR ART)

300

302

$E = [0\ 1\ 0\ {-1}\ 0]$ <INPUT SYMBOL SEQUENCE

304

$$C = \begin{vmatrix} 1 & 2 & 3 & 4 & 5 & 1 \\ -5 & -4 & -3 & -2 & -1 & 4 \\ 3 & 2 & -3 & -1 & -2 & -3 \\ 3 & -4 & -2 & 2 & 1 & 2 \\ 3 & -4 & 5 & 2 & 1 & -3 \end{vmatrix}$$

<2 DIMENSIONAL TRANSMISSION MATRIX

306

$F = E * C = [-8\ 0\ {-1}\ {-4}\ {-2}\ 2]$ <TRANSMIT SYMBOL SEQUENCE

308

$F5 = [-8\ 0\ {-1}\ {-4}\ 2]$ <RECEIVED SYMBOL SEQUENCE WITH CORRUPT TERM REMOVED

310

$$C5 = \begin{vmatrix} 1 & 2 & 3 & 4 & 1 \\ -5 & -4 & -3 & -2 & 4 \\ 3 & 2 & -3 & -1 & -3 \\ 3 & -4 & -2 & 2 & 2 \\ 3 & -4 & 5 & 2 & -3 \end{vmatrix}$$

<TRANSMISSION MATRIX WITH CORRUPT ~~ROW~~ COLUMN REMOVED

312

$$K5 = \begin{vmatrix} -.3528 & -.4410 & -.3658 & .2529 & -.1712 \\ -.0110 & -.1388 & -.0739 & -.0233 & -.1304 \\ -.2335 & -.2918 & -.3891 & .0350 & -.0545 \\ .6005 & .5006 & .5564 & -.1401 & .2179 \\ -.3268 & -.4086 & -.5447 & .2490 & -.2763 \end{vmatrix}$$

<INVERSE OF C5 IS A RECOVERY MATRIX

314

$G = F5 * K5 = [0\ 1\ 0\ {-1}\ 0]$ <OUTPUT SYMBOL SEQUENCE

FIG 3

REPLACEMENT SHEET

300

$E = [0\ 1\ 0\ -1\ 0]$ 302 <INPUT SYMBOL SEQUENCE

$$C = \begin{vmatrix} 1 & 2 & 3 & 4 & 5 & 1 \\ -5 & -4 & -3 & -2 & -1 & 4 \\ 3 & 2 & -3 & -1 & -2 & -3 \\ 3 & -4 & -2 & 2 & 1 & 2 \\ 3 & -4 & 5 & 2 & 1 & -3 \end{vmatrix}$$

304 <2 DIMENSIONAL TRANSMISSION MATRIX

$F = E \cdot C = [-8\ 0\ -1\ -4\ -2\ 2]$ 306 <TRANSMIT SYMBOL SEQUENCE

$F5 = [-8\ 0\ -1\ -4\ 2]$ 308 <RECEIVED SYMBOL SEQUENCE WITH CORRUPT TERM REMOVED

$$C5 = \begin{vmatrix} 1 & 2 & 3 & 4 & 1 \\ -5 & -4 & -3 & -2 & 4 \\ 3 & 2 & -3 & -1 & -3 \\ 3 & -4 & -2 & 2 & 2 \\ 3 & -4 & 5 & 2 & -3 \end{vmatrix}$$

310 <TRANSMISSION MATRIX WITH CORRUPT COLUMN REMOVED

$$K5 = \begin{vmatrix} -.3528 & -.4410 & -.3658 & .2529 & -.1712 \\ -.0110 & -.1388 & -.0739 & -.0233 & -.1304 \\ -.2335 & -.2918 & -.3891 & .0350 & -.0545 \\ .6005 & .5006 & .5564 & -.1401 & .2179 \\ -.3268 & -.4086 & -.5447 & .2490 & -.2763 \end{vmatrix}$$

312 <INVERSE OF C5 IS A RECOVERY MATRIX

$G = F5 \cdot K5 = [0\ 1\ 0\ -1\ 0]$ 314 <OUTPUT SYMBOL SEQUENCE

FIG 3